

Administrative Procedure

PRC-PRO-SH-121

Heat Stress Control

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**Project: CH2M HILL Plateau Remediation Company
Topic: Occupational Safety & Industrial Hygiene**

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<h1>Administration Use</h1>

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Description of Change

8/5/09, Rev.0-3: Editorial changes to update ACGIH reference from “current edition” to “2005 edition” to conform to 10 CFR 851. Addition of Applicability and Responsibilities sections to match CHPRC PRO template. Corrected section call outs as well as added abbreviation explanations throughout document.

6/24/09, Rev.0-2: Incorporated editorial changes to update nomenclature of referenced procedures (step 2.2.3.c and section 5.2).

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1.0 INTRODUCTION**1.1 Purpose**

This procedure establishes requirements and processes for working in conditions with the potential for heat stress on the Hanford Site. Following these requirements will assist in compliance with:

- Occupation Safety and Health Act (OSHA) general duty clause and 29 CFR 1926.10(a) general requirements to ensure worker health and safety.
- OSHA 29 CFR 1926.65 and 29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*, requirements for control of heat stress conditions during hazardous waste activities.
- Heat stress exposure limits specified in American Conference of Governmental Industrial Hygienists (ACGIH) *Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices*, (TLV/BEI) (2005 Edition).

1.2 Scope

Certain medical services are not within the scope of this document, including:

- Medical intervention for treatment of heat strain illness by the first aid provider or medical providers.
- Fitness-for-duty protocol or medical certification to perform work in hot environments.

In addition, abnormal or emergency response activities where work planning is not practical (such as fire department and patrol) are not covered by this procedure and will be addressed as part of the emergency response.

1.3 Applicability

This Level 2 Management Control Procedure is applicable to CH2M HILL Plateau Remediation Company (CHPRC) Team employees who may work in environments with a potential for heat stress.

1.4 Implementation

This procedure is effective upon publication.

2.0 RESPONSIBILITIES

All responsibilities associated with this procedure are identified in the process steps.

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3.0 PROCESS

This section addresses the following processes:

[Section 3.1](#).....Identification and Evaluation of Heat Stress Conditions

[Section 3.2](#).....Applying Heat Stress Control Strategies

[Section 3.3](#).....Employee Awareness and Training

[Section 3.4](#).....Medical Aspects of Heat strain Control

3.1 Identification and Evaluation of Heat Stress Conditions

Actionee	Step	Action
Line Management	1.	Prior to performing work, evaluate whether the potential for heat stress exists. If necessary, contact the health and safety professional to assist in this evaluation. Consider the following risk factors in this evaluation:
	a.	High temperature.
	b.	Humidity.
	c.	Sources of radiant heat, such as steam pipes, boilers, heated vessels.
	d.	Use of protective clothing (coveralls, Tyvek coveralls, semi-permeable, or impermeable chemical protective clothing) which can impair the body's ability to regulate heat.
	e.	Work requiring moderate to heavy physical labor.
	f.	Outdoor operations conducted in hot weather, such as construction, asbestos removal, or hazardous waste activities.
	g.	Direct physical contact with hot objects.
	h.	Work performed in greenhouses or other enclosures during conditions that could result in heat buildup or other environments with minimal air movement.

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Actionee	Step	Action
NOTE: <i>If weather and environmental conditions change because of the time elapsed between preparation of the Job Hazard Analysis (JHA) or work planning documents and conduct of the work, the potential for heat stress should be re-evaluated at or around the time the work is to be conducted.</i>		
	2.	If the task is determined to have potential heat stress, perform a job hazard analysis using the Automated Job Hazard Analysis (AJHA) or similar tool. Include the health and safety professional in this analysis. Refer to Appendix A to determine if this is a high heat situation or determine if heat strain controls are necessary. If either of these conditions exist, notify the Heat Stress Subject Matter Expert (SME) or Industrial Hygiene Manager of the need for physiological monitoring prior to performing the work.
NOTE: <i>The Hanford ALARA Center may be contacted to obtain information on available methods and technologies to manage potential heat stress conditions.</i>		
	3.	If the health and safety professional determines that heat stress controls are necessary, implement recommended heat stress controls. These controls may include both engineering and administrative controls as well as personal protective equipment.
	4.	As needed, obtain and use Wet bulb globe temperature (WBGT) data, the classification of the work activity level (workload), and the information in Appendix A (with Industrial Hygiene involvement) to establish work/rest regimens.
NOTE: <i>It is not necessary to log WBGT readings obtained from the weather station.</i>		
Health and Safety Professional	5.	Collect and record WBGT data on the <i>CHPRC Industrial Hygiene WBGT Survey Form</i> (Site Form A-6004-739) whenever worksite WBGT readings are obtained.
	6.	As requested, assist line management in evaluating the potential for heat stress on a task. The completed form should be submitted to the Industrial Hygiene Programs Records Coordinator as outlined in PRC-PRO-SH-409, <i>Industrial Hygiene Monitoring, Reporting, and Records Management</i> .
NOTE: <i>Additional guidance for using Figure 1 can be found in the 2005 edition of TLV/BEI, published by the ACGIH.</i>		
	7.	Review and participate in the JHA or similar hazard analysis process. If heat stress is expected, use the evaluation scheme shown in Figure 1 to perform a detailed analysis of the expected heat stress levels.
	8.	If necessary, classify the work load category as light, moderate, or heavy, according to type of activity performed (see Appendix A).

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Actionee	Step	Action
	9.	Conduct or interpret workplace environmental measurements (apparent temperature or WBGT index) where heat stress potential exists.
	10.	Determine the permissible heat exposure TLV for the workloads (see Appendix A).

3.2 Applying Heat Stress Control Strategies

Actionee	Step	Action
Line Management	1.	Ensure work performed in a hot environment is under the observation of a supervisor who knows the early signs/symptoms of heat illness and who can enforce the permissible work/rest regimen and other established controls.
	2.	Allow appropriate time for worker acclimatization prior to work in a hot environment (see Appendix B). Consult Industrial Hygiene for guidance on establishing acclimatization regimens for the activity.
	3.	Ensure water/fluids are provided to workers as needed and whenever work/rest regimens or other controls are instituted to prevent heat strain.

NOTE: *Recommended intake is 8 ounces (1 cup) of cool water (10-15°C or 50-60°F) every 15-20 minutes.*

- a. Encourage workers to consume adequate quantities of water.

NOTE: *Salt tablets are not recommended.*

- b. Ensure water is readily accessible to employees in the work area, if feasible. Encourage workers to drink fluids prior to entering the work area.
- c. If the health and safety professional determines that heat strain conditions exist in a radiological contamination area, provide fluids in accordance with CHPRC-00073, *CH2M HILL Plateau Remediation Company Radiological Control Manual*.

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Actionee	Step	Action
NOTE:		
		<ul style="list-style-type: none"> When temperatures are at or in excess of 35°C (95°F), forced air ventilation should not be used unless the ventilation air is cooled. Examples of engineering controls include insulation or shielding of hot equipment and surfaces, local exhaust ventilation, and forced ventilation of a work area. Examples of administrative controls include scheduling work for cooler parts of the day, rotating tasks among workers, and applying work/rest regimens.
	4.	When feasible, provide engineering and administrative controls to reduce the potential for exposure to heat stress conditions.
	5.	Adjust the employee's work schedule, work load, and work/rest regimen as prescribed by the health and safety professional.
	6.	Establish worksite-specific heat stress surveillance (see Appendix C) with the health and safety professional when indicated in Section 3.1 .
	7.	Provide a cool-down area adjacent to the hot environment. Adjust the length of the cool-down period in accordance with guidelines for applicable work/rest regimens and ACGIH TLVs.
	8.	Provide personal protective equipment, cooling devices, and accessory equipment, (such as insulated gloves, reflective clothing, cool ties, ice vests, vortex suits), as recommended by the health and safety professional.
	9.	Ensure jobs which require the use of respiratory protection, radiological, or chemical protective clothing are planned with consideration of the stressors that protective clothing can contribute to the overall heat stress potential.
	10.	Implement personal monitoring strategies when appropriate and as recommended by the health and safety professional. (See Appendix D .)
	11.	Ensure that records generated from heat stress evaluation and control are maintained with the work package records.
Health and Safety Professional	12.	Assist line management in applying heat stress exposure guidelines using Figure 1 to evaluate the potential for heat stress. <ul style="list-style-type: none"> Establish the work/rest regimen with respect to temperature, work load, protective clothing, and cooling devices. Identify other factors which may alter the interpretation and use of Figure 1, and determine exposure limits accordingly.

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Actionee	Step	Action
	13.	Recommend appropriate personal and environmental monitoring methodologies, engineering controls, administrative controls, and personal protective equipment to prevent heat strain.
	14.	Collect, interpret, and document worksite-specific personal heat strain or environmental monitoring data as appropriate. Methods for personal monitoring are in Appendix D .
	15.	Based on temperature, work load category, and protective clothing requirements determine if workers will need cooling devices while performing tasks.
	16.	As requested, assist line management in purchase, issue, and use of cooling devices or other protective equipment.

3.3 Employee Awareness and Training

Actionee	Step	Action
Line Management	1.	Ensure that employees who are working in or supervising work in hot environments are trained in heat stress recognition, prevention, and control. Training should address: <ul style="list-style-type: none">a. Identification of heat stress hazards and potential health effects.b. Predisposing factors and relevant signs and symptoms of heat injury and illness.c. Information on water intake replacement.d. Heat strain control strategies such as work practices and engineering controls, proper acclimatization, and proper use of heat strain personal protective equipment.e. Potential for therapeutic drugs, over-the-counter medications, or social drugs (including alcohol) to increase the risk of heat injury or illness by reducing heat tolerance.

NOTE: *There is currently a Hanford training course in HGET relating to heat stress. The course (020193) provides an introduction to heat stress including signs and symptoms, as well as information on heat stress measurements and heat stress control measures. While it is not necessary to complete this course, the course was designed to meet the requirements noted above.*

2. Conduct and document this training in a training course, safety meeting, pre-job briefing, or other appropriate forum.
3. Include worksite-specific heat strain prevention information in regular pre-job briefings. Communicate temperature readings, environmental data, and heat stress information to affected employees.

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Actionee	Step	Action
Health and Safety Professional	4.	As requested, participate in pre-job briefings or other processes communicating the hazards associated with heat stress conditions at the work site and the control methods to be used.
	5.	As appropriate, contribute to training of management and employees in heat stress related topics.
Employees	6.	Participate in heat strain prevention activities, including training and pre-job briefings.
	7.	Be aware of means to avoid heat strain such as adequate water consumption.
	8.	Recognize the signs and symptoms of heat strain.
	9.	If signs and symptoms of heat strain develop, inform supervisors and take appropriate action, such as immediately exiting the work area.

3.4 Medical Aspects of Heat Strain Control

Actionee	Step	Action
Line Management	1.	Recognize work conditions that may require employees to be medically evaluated to work in a hot environment.
	2.	Ensure first aid and emergency procedures for response to heat strain related illnesses are established and communicated to employees.
Medical Contractor	3.	As requested by line management, assess employee's capacity to work in a hot environment and to wear prescribed personal protective equipment in hot environments.
	4.	Provide medical treatment and intervention strategies, as appropriate.
Health and Safety Professional	5.	Investigate heat strain disorder cases as requested by the Safety Department Injury/Illness Investigation group. Provide results to line management.

4.0 FORMS*CHPRC Industrial Hygiene WBGT Survey Form, A-6004-739*

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5.0 RECORD IDENTIFICATION

Performance of this procedure may generate the following records.

Records Capture Table

Name of Record	Submittal Responsibility	Retention Responsibility	OCRWM Retention Schedule (If OCRWM Related)
CHPRC Industrial Hygiene WBGT Survey Form, A-6004-739	Project Industrial Hygienist	Retained in work package.	N/A

6.0 SOURCES

6.1 Requirements

10 CFR 851, *Worker Safety and Health Program*

OSHA general duty clause, OSHA 29 CFR 1926.65 and 29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*

American Conference of Governmental Industrial Hygienists (ACGIH), "*Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*" (2005 edition).

29 CFR 1910.1020, *Access to Employee Exposure and Medical Records*

NOTE: For the tables in this section under the requirement "type" column, "V" means verbatim and "I" means interpreted.

#	REQUIREMENT	TYPE V or I	SOURCE
1.	If the job hazard analysis (JHA) indicates the potential for heat stress, the heat stress requirements of the 2005 edition of the ACGIH TLV/BEI must be followed.	I	10 CFR 851.23(a)(9)
2.	Prior to performing work on the Hanford Site, the potential for heat stress must be evaluated. This evaluation will be part of the JHA, and the Automated Job Hazard Analysis (AJHA) or similar tool may be used to perform the analysis. NOTE: Details of the Job Hazard Analysis process is contained in PRC-PRO-WKM-079, <i>Job Hazard Analysis</i> .	I	ACGIH

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#	REQUIREMENT	TYPE V or I	SOURCE
3.	<p>The project/facility Occupation Safety and Health (OS&H) professional must be involved in the evaluation of the heat stress level and implementation of heat strain controls if the JHA indicates a potential for heat stress.</p> <p>NOTE: <i>For outdoor work, general wet bulb globe temperature (WBGT) values (if needed) can be obtained from the Pacific Northwest National Laboratory (PNNL) weather station. For indoor work, or where the outdoor values are not applicable, a person trained in how to operate and interpret WBGT equipment must take job site WBGT values.</i></p>	I	10 CFR 851, Appendix A, 6.a
4.	<p>The detailed analysis outlined in Section 3 of ACGIH TLV/BEIs, 2005 edition (if required) shall be performed by the project/facility OS&H professional.</p>	I	10 CFR 851, Appendix A, 6.a
5.	<p>The project/facility OS&H professional shall review the Employee Job Task Analysis (and update if necessary) if the heat stress levels are high enough that a work/rest regimen is implemented.</p>	I	10 CFR 851, Appendix A, 6.a
6.	<p>Line management shall ensure that each employee who is potentially exposed to heat stress is provided with documented training, appropriate for the use situations/locations where the exposure(s) could occur. The instruction shall include:</p> <ul style="list-style-type: none">• Medical conditions resulting from heat strain,• Possible source of exposure, including job, environmental,• How to minimize the potential for heat strain to occur,• Engineering/administrative controls for heat stress, and• Emergency procedures for heat-related illnesses. <p>NOTE: <i>There is currently a Hanford training course in Hanford General-Employee Training (HGET) relating to heat stress in addition to heat stress awareness in core HGET training. The course (020193) provides an introduction to heat stress including signs and symptoms, as well as information on heat stress measurements and heat stress control measures. While it is not necessary to complete this course, the course was designed to meet the requirements noted above.</i></p>	I	10 CFR 851.25(a)

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#	REQUIREMENT	TYPE V or I	SOURCE
7.	<p>For most situations, it will not be necessary to evaluate personal heat strain levels. However, if these measurements are taken, they shall be considered personal exposure monitoring data and handled in accordance with PRC-PRO-SH-409.</p> <p>NOTE: <i>Form WBGT Monitoring (Site Form A-6004-691) has been developed to record this data. Another equivalent form can be used in lieu of this form provided it contains the same information.</i></p> <p>NOTE: <i>Heat stress levels (WBGT values) from the general area or the PNNL weather station are not considered personal exposure monitoring data and do not need to be recorded per PRC-PRO-SH-409.</i></p>	I	29 CFR 1910.1020, (c)(5)(i)

6.2 References

CHPRC-00073, CH2M HILL Plateau Remediation Company Radiological Control Manual
PRC-PRO-WKM-079, Job Hazard Analysis
PRC-PRO-SH-409, Industrial Hygiene Monitoring, Reporting and Records Management
29 CFR 1926.10(a), General interpretations, Safety and Health Regulations for Construction
Bernard and Kenney, 1994
Standard Operating Safety Guides, EPA, 1992
NIOSH, 1986, Revised Criterion, Cincinnati, Ohio

7.0 APPENDIXES

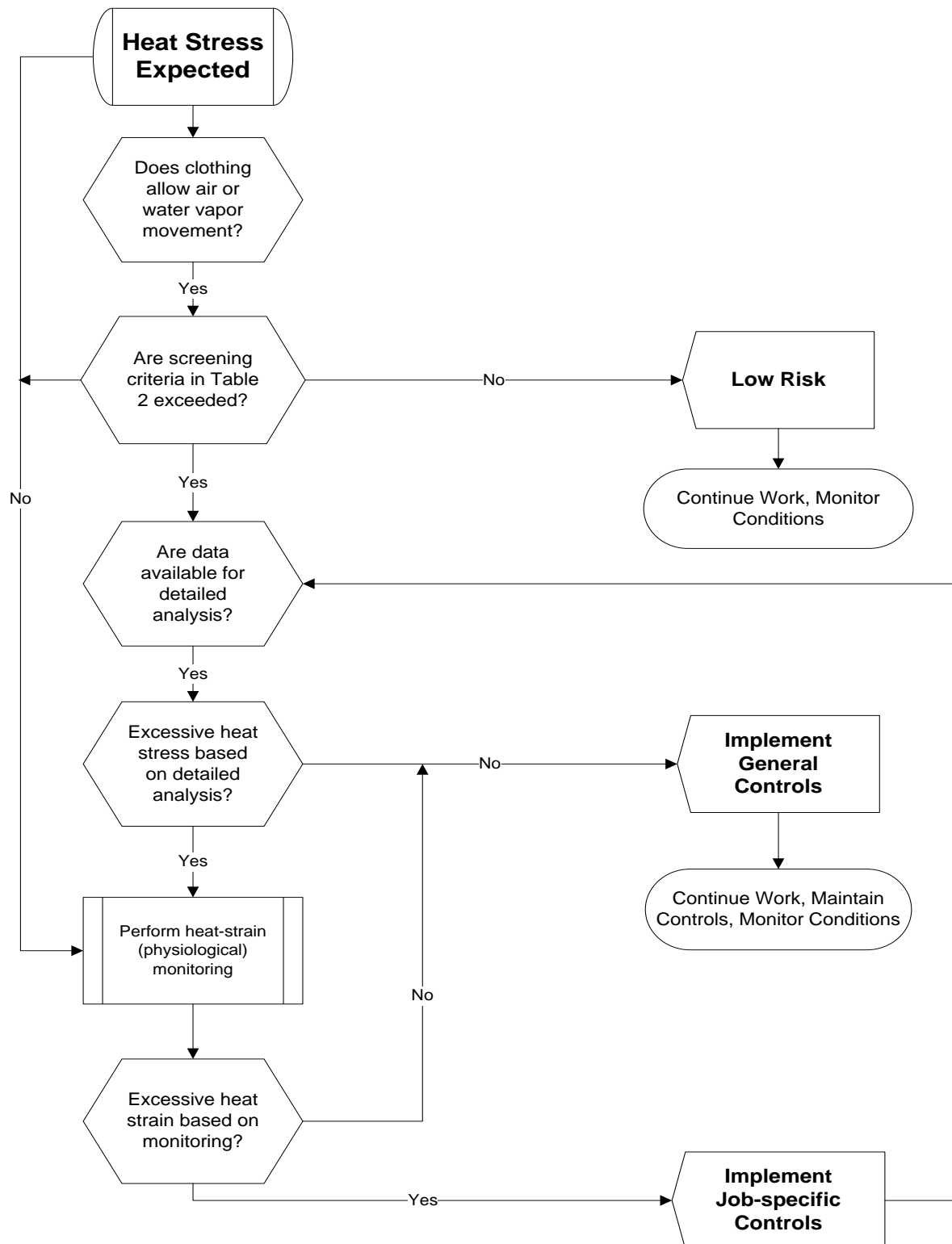
[Appendix A](#) -- Establishing Work/Rest Regimens
[Appendix B](#) -- Glossary
[Appendix C](#) -- Monitoring the Work Environment
[Appendix D](#) -- Personal Monitoring

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FIGURE 1 -- Evaluation Scheme for Heat Stress



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TABLE 1 - Additions to Measured WBGT Values (°C) For Some Clothing Ensembles

Clothing Type	WBGT Addition*
Summer work uniform	0 (0°F)
Cloth (woven material) overalls**	+3.5 (6°F)
Double-cloth overalls***	+5 (9°F)

*These values must **not** be used for encapsulating suits or garments that are impermeable or highly resistant to water vapor or air movement through fabrics.

NOTE: The following two recommendations are non-mandatory.

**This value can also be used for a single pair of anti-C clothing with modesty clothing.

***This value can also be used for two pairs of anti-C clothing with modesty clothing.

Additional guidance on heat stress clothing correction factors can be found at
<http://idmsweb/idmsprod/livelink.exe?func=ll&objId=5656727&objAction=Open>

TABLE 2 - Screening Criteria for Heat Stress Exposure
 (WBGT values in °C)

Work Demands	Acclimatized				Unacclimatized			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
100% Work	29.5 (85.1°F)	27.5 (81.5°F)	26 (78.8°F)		27.5 (81.5°F)	25 (77.0°F)	22.5 (72.5°F)	
75% Work; 25% Rest	30.5 (86.9°F)	28.5 (83.3°F)	27.5 (81.5°F)		29 (84.2°F)	26.5 (79.7°F)	24.5 (76.1°F)	
50% Work; 50% Rest	31.5 (88.7°F)	29.5 (85.1°F)	28.5 (83.3°F)	27.5 (81.5°F)	30 (86.0°F)	28 (82.4°F)	26.5 (79.7°F)	25 (77.0°F)
25% Work; 75% Rest	32.5 (90.5°F)	31 (87.8°F)	30 (86.0°F)	29.5 (85.1°F)	31 (87.8°F)	29 (84.2°F)	28 (82.4°F)	26.5 (79.7°F)

NOTE:

- See Table 3 and the Documentation for work demand categories.
- WBGT values are expressed in °C, and represent thresholds near the upper limit of the metabolic rate category.
- If work and rest environments are different, hourly time-weighted averages (TWA) should be calculated and used. TWAs for work rates should also be used when the work demands vary within the hour. Additional guidance for calculating WBGT values for work/rest regimens can be found at
<http://idmsweb/idmsprod/livelink.exe?func=ll&objId=5656727&objAction=Open>

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- *Values in the table are applied by reference to the “Work/Rest Regimen” section of the Documentation and assume 8-hour workdays in a 5-day workweek with conventional breaks, as discussed in the Documentation. When workdays are extended, consult the “Application of the TLV” section of the Documentation.*
- *Because of the physiological strain associated with Very Heavy work among less fit workers regardless of WBGT, criteria values are not provided for continuous work and for up to 25% rest in an hour. The screening criteria are not recommended, and a detailed analysis and/or physiological monitoring should be used.*

TABLE 3 - Examples of Activities within Metabolic Rate Categories

Categories	Examples Activities
Resting	Sitting quietly.
	Sitting with moderate arm movements.
Light	Sitting with moderate arm and leg movement.
	Standing with light work at machine or bench while using mostly arms.
	Using a table saw.
	Standing with light or moderate work at machine or bench and some walking about.
Moderate	Scrubbing in a standing position.
	Walking about with moderate lifting or pushing.
	Walking on level at 6 Km/hr while carrying 3 Kg weight load.
Heavy	Carpenter sawing by hand.
	Shoveling dry sand.
	Heavy assembly work on a noncontinuous basis.
	Intermittent heavy lifting with pushing or pulling (e.g., pick-and-shovel work).
Very Heavy	Shoveling wet sand.

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Appendix A -- Establishing Work/Rest Regimens

Table 2 provides ACGIH heat stress TLVs (work/rest regimens) for several work activity levels. The application of work/rest regimens varies depending on the work activity level (workload), WBGT indices, clothing, worker's level of acclimatization, and water availability. This table assumes that employees do not wear protective equipment to reduce heat exposure. When personal protective equipment is used to reduce heat exposure (e.g., ice vests, vortex suits, etc.), a health and safety professional should be contacted for guidance on how to apply this table.

1. Establish the estimated work activity level (workload) by referring to Table 3.

NOTE: *For tasks that involve more than one category, use the most restrictive category; consult a health and safety professional for guidance.*

2. Measure (or estimate) worksite-specific WBGT values. (Estimated values can be based on data provided by the PNNL weather station).
3. Apply appropriate clothing correction factor from Table 1.
4. Establish a work/rest regimen by applying information obtained from Steps 1, 2 and 3 to Table 2. See Step 5 for restrictions or conditions that do not apply.
5. Notify Heat Stress SME or IH Manager regarding work in high heat situations where WBGT monitoring is inappropriate or additional direction is needed. These situations include: , or to address heat strain controls for:
 - Any situation where heat strain (physiologic) monitor is deemed necessary.
 - Use of clothing types not listed in Table 1 including chemical protective clothing, clothing prescribed for protection against both radiological and chemical hazards (Saranex-laminated Tyvek), clothing providing a water barrier, clothing that is heavier, impedes sweat evaporation, or has a higher insulation value, or impermeable clothing.
 - Use of multiple layers of clothing types other than those listed in Table 1.
6. In addition, the Heat Stress SME or IH Manager can provide advice when work involves:
 - Conditions in the 25% work/75% rest column of Table 2.
 - Work in enclosures, containment structures, or greenhouses.
 - Use of personnel protective equipment to prevent heat strain including cooling devices (vortex coolers and ice vests).
 - Work shifts of more than 8 hours.

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Appendix B -- Glossary

TERM	DEFINITION
acclimatization	The gradual adaptation of an individual to a hot environment. The degree to which a worker is acclimatized to hot environments directly affects how well the body tolerates heat load. Age, gender, and physical fitness affect the period of time for acclimatization to occur; acclimatization can usually be achieved after five to seven days of graduated exposure at the hot job.
apparent temperature	A temperature and relative humidity index provided by PNNL weather station that relates to potential for various heat syndromes; based on National Weather Association apparent temperature chart.
cool down area	A rest area normally located as close to the worksite as possible, where workers can periodically enter to cool down after working in hot environments. As a guideline only, areas should be shaded and maintained cooler than the work area, preferably as close to 24°C (76°F) as possible.
core body temperature	Temperature of the internal core body. Both ACGIH and NIOSH cite a core body temperature of 38°C or 100.4°F as the limit for daily, prolonged work under heat stress conditions. Measured in the field either by tympanic, skin, or oral temperature readings.
heat strain	<p>Physiological response to heat stress recognized by:</p> <ul style="list-style-type: none">• Increased core body temperature.• Increased heart rate.• Sweating. <p>If these responses are not controlled, these symptoms may progress and result in increased incidence of heat strain disorders and accident rates.</p>
heat stress	The total heat load on the body that results from exposure to external sources and from internal metabolic heat production due to physical work. It occurs when the body produces or gains more heat than it is capable of giving off or losing. Contributing environmental factors affecting the potential for heat strain include air temperature, humidity, radiant heat exchange, and air movement.
heat exhaustion	A heat disorder recognized by profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. The skin is cool and sometimes pale and clammy with sweat. Body temperature is normal or subnormal, and nausea, vomiting, and unconsciousness may occur.
heat stroke	A life-threatening heat disorder characterized by diminished or absent sweating. The skin is hot, dry, and flushed. Increased core body temperature, which, if uncontrolled, may lead to delirium, convulsions, coma, and even death. Medical care is urgently needed.

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TERM	DEFINITION
hot environment	A work area where one or more of the following factors may exist, creating the potential for heat strain: high temperature/humidity, sources of significant radiant heat, or use of protective clothing which impedes sweat evaporation.
rest	A total cessation of work in the hot environment and relocation to a shaded environment to allow for cool-down between work periods. Personal protective equipment (PPE) should be removed (as possible) during rest periods.
street clothing	Clothing ensemble including briefs, ankle socks, shoes, trousers, long sleeve shirt.
summer clothing	Clothing ensemble including briefs, ankle socks, shoes, short-sleeved shirt, walking shorts.
threshold limit values (TLVs) for heat stress	ACGIH values incorporate work exertion level, PPE in use, and WBGT temperatures to determine a work/rest regimen that permit nearly all workers to be repeatedly exposed to hot work environments without adverse health effects. TLVs are based on the assumption that nearly all acclimatized, fully clothed workers with adequate water and dietary salt intake should be able to function effectively under the given working conditions without exceeding a core body temperature of 38°C (100.4°F).
wet bulb globe temperature (WBGT)	Environmental temperature index used to assess the potential for heat strain. WBGT values may be measured with integrated equipment or calculated using readings from a globe thermometer, a natural (static) wet-bulb thermometer, and a dry-bulb thermometer.
work/rest regimen	The proportion of time that an individual spends working and resting during an hour duration, and is established based on the WBGT index, work activity level (workloads) exertion level, personal protective equipment worn, and acclimatization status.

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Appendix C -- Monitoring the Work Environment

Thermal stress is a function of air temperature, solar and thermal radiation, relative humidity, air movement, and the physiologic condition of the worker. Where conditions of humidity, sunlight, or radiant heat exist, ***dry bulb measurements alone are inadequate*** as indicators of the proper work/rest regimen. Environmental monitoring instrumentation is obtainable through the Industrial Hygiene Equipment Lab (IHEL). Automated equipment is available that integrates the three temperature measurements and provides a digital readout. If equipment is used that provides individual wet bulb, globe, or dry bulb temperature measurements, use one of the two WBGT indices below:

(a) Equation 1 is applicable to outdoor conditions with solar load:

$$\text{WBGT} = 0.7 (\text{wet bulb temp.}) + 0.2 (\text{globe temp.}) + 0.1 (\text{dry bulb temp.})$$

(b) Equation 2 is applicable to indoor/outdoor conditions without solar load:

$$\text{WBGT} = 0.7 (\text{wet bulb temp.}) + 0.3 (\text{globe temp.})$$

Table 2 lists WBGT temperature ranges where heat stress conditions may exist. WBGT readings in these ranges may indicate a need for work/rest regimens to be applied or personal monitoring to be performed. Interpretation of the table depends on the work activity level and specifically defined clothing worn by workers.

At present, the PNNL Weather Station in the 200 area provides WBGT readings during daylight hours, Monday through Friday, between May 1 and October 1, and until 12:00 p.m. on weekends and holidays. These readings are taken between 200 East and 200 West, and can be used as general guidance for most outdoor locations at Hanford. However, depending on specific worksite conditions, they may not be directly applicable for a specific worksite.

As determined by Industrial Hygiene, supplementary WBGT readings may be necessary when work is performed inside containment tents, greenhouses, or other enclosures between the spring and fall months (approximately May 1 to October 1).

Heat Stress Control

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Appendix D -- Personal Monitoring

Personal monitoring (also known as heat strain or physiological monitoring) is not a routine requirement. However, it is necessary in certain applications when impermeable clothing is used or the potential for heat strain cannot be ruled out based on available data. In these situations, engineering controls should be relied upon as the principal method for reducing heat strain. If the potential remains for heat strain after implementing engineering controls, physiological monitoring should be used to monitor heat strain levels. Such monitoring should only be performed after notifying the Heat Stress SME or Industrial Hygiene Manager of the need to implement physiological monitoring. This appendix is for information purposes only and to provide background information on various methods of heat strain monitoring for the health and safety professional. It is not intended to recommend specific equipment or procedures, and it should not be construed as containing all considerations to be addressed in implementing physiological monitoring.

The American Conference of Governmental Industrial Hygienists (ACGIH) recognizes four measures for evaluating excessive levels of heat strain. These are: sustained heart rate, body core temperature, recovery heart rate and physical symptoms of excessive heat strain. Excessive heat strain is occurring when any one of these four criteria is present/exceeded. Each is discussed briefly below.

Excessive heat strain measured using sustained heart rate occurs when the sustained heart rate (SHR) (over several minutes) is in excess of 180 beats per minute minus the individual's age in years (Ay). Expressed as an equation: if $SHR > (180 - Ay)$, excessive heat stress is present. This applies only to individuals with assessed normal cardiac performance.

Excessive heat strain when body core temperature is greater than 38.5°C (101.3°F) for medically selected and acclimatized personnel, or greater than 38°C (100.4°F) for unselected, unacclimatized workers.

Excessive heat strain when recovery heart rate at one minute after a peak work effort is greater than 100 beats per minute.

Excessive heat strain when one or more of the following symptoms are observed: sudden and severe fatigue, nausea, dizziness, or lightheadedness.